

01FN046US
Amendment dated 09/22/2003

09/916,529
Reply to office action mailed 06/23/2003

02230028aa

Amendments to the Specification:

Please replace the paragraph beginning at page 6, line 1, with the following rewritten paragraph:

A magneto-resistance effect element according to the present invention comprises a lower conductive layer, a magnetic layer provided on the lower conductive layer, and a free layer provided on the magnetic layer and having an orientation of magnetization varied by a magnetic field coupled magnetically to the magnetic layer and applied thereto. The magneto-resistance effect element also comprises a non-magnetic layer provided on the free layer, a fixed layer provided on the non-magnetic layer and having a pinned orientation of magnetization, and a vertical bias layer, provided on the lower conductive layer, for applying a magnetic field to the free layer. The magneto-resistance effect element is adapted such that the magnetic layer is greater in length, in the direction of a magnetic field applied thereto by the vertical bias layer, than the free layer, and a sense current for detecting a change in electrical resistance of the non-magnetic body flows substantially in perpendicular relation to the non-magnetic layer.

Please replace the paragraph beginning at page 7, line 17, with the following rewritten paragraph:

Furthermore, at least part of the free layer can be brought into direct contact with the vertical bias layer. Alternatively, the underlying layer for the free layer may be provided below the free layer such that the underlying layer for the free layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer such that the vertical bias layer protective

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

layer is brought into contact with the free layer or the underlying layer for the free layer.

Please replace the paragraph beginning at page 9, line 10, with the following rewritten paragraph:

Furthermore, at least part of the magnetic layer can be brought into direct contact with the vertical bias layer. Alternatively, the underlying layer for the magnetic layer may be provided below the magnetic layer such that the underlying layer for the magnetic layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer such that the vertical bias layer protective layer is brought into contact with the magnetic layer or the underlying layer for the magnetic layer.

Please replace the paragraph beginning at page 10, line 11, with the following rewritten paragraph:

Furthermore, it is preferable that at least part of the magnetic layer is brought into direct contact with the vertical bias layer. Alternatively, the underlying layer for the magnetic layer may be provided below the magnetic layer such that the underlying layer for the magnetic layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer such that the vertical bias layer protective layer is brought into contact with the magnetic layer or the underlying layer for the magnetic layer.

Please replace the paragraph beginning at page 11, line 18, with the following rewritten paragraph:

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Furthermore, a second non-magnetic layer can be provided between the free layer and the first magnetic layer, while a third non-magnetic layer can be provided between the first magnetic layer and the second magnetic layer. In addition, an underlying layer for the fixing layer may be provided under the fixing layer.

Please replace the paragraph beginning at page 12, line 22, with the following rewritten paragraph:

In addition, it is desirable that at least part of the first magnetic layer is in direct contact with the vertical bias layer. Alternatively, a first underlying layer for the magnetic layer may be provided below the first magnetic layer such that the first underlying layer for the magnetic layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer such that the vertical bias layer protective layer is brought into contact with the first magnetic layer or the first underlying layer for the magnetic layer. Similarly, it is desirable that at least part of the second magnetic layer is in direct contact with the vertical bias layer. Alternatively, a second underlying layer for the magnetic layer may be provided below the second magnetic layer such that the second underlying layer for the magnetic layer is brought into contact with the vertical bias layer. The vertical bias layer protective layer may also be brought into contact with the second magnetic layer or the second underlying layer for the magnetic layer.

Please replace the paragraph beginning at page 13, line 12, with the following rewritten paragraph:

A magneto-resistance effect element according to the present invention comprises a lower conductive layer, a fixed layer provided on the lower conductive layer and having a pinned orientation of magnetization, and a non-magnetic layer

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

provided on the fixed layer. The magneto-resistance effect element also comprises a free layer provided on the non-magnetic layer and having an orientation of magnetization varied by a magnetic field applied thereto, a magnetic layer provided on the free layer, and a vertical bias layer, provided on the magnetic layer, for applying a magnetic field to the magnetic layer. The magneto-resistance effect element is adapted such that a sense current for detecting a change in electrical resistance of the non-magnetic layer flows substantially in perpendicular relation to the non-magnetic layer.

Please replace the paragraph beginning at page 13, line 26, with the following rewritten paragraph:

A magneto-resistance effect element according to the present invention comprises a lower conductive layer, a first fixed layer provided on the lower conductive layer and having a pinned orientation of magnetization, and a first non-magnetic layer provided on the first fixed layer. The magneto-resistance effect element also comprises a first free layer provided on the first non-magnetic layer and having an orientation of magnetization varied by a magnetic field applied thereto. The magneto-resistance effect element further comprises a magnetic layer provided on the first free layer and magnetically coupled to the first free layer, and a second free layer provided on the magnetic layer and magnetically coupled to the magnetic layer. The magneto-resistance effect element also comprises a second non-magnetic layer provided on the second free layer, a second fixed layer provided on the second non-magnetic layer and having a pinned orientation of magnetization, and a vertical bias layer for applying a magnetic field to the magnetic layer. The magneto-resistance effect element is adapted such that a sense current for detecting a change in electrical

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

resistance of the first and second non-magnetic layers flows substantially in perpendicular relation to the first and second non-magnetic layers.

Please replace the paragraph beginning at page 15, line 17, with the following rewritten paragraph:

In addition, it is preferable that at least part of the magnetic layer is in direct contact with the vertical bias layer. Alternatively, the underlying layer for the magnetic layer may be provided below the magnetic layer such that the underlying layer for the magnetic layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer such that the vertical bias layer protective layer is brought into contact with the magnetic layer or the underlying layer for the magnetic layer.

Please replace the paragraph beginning at page 15, line 26, with the following rewritten paragraph:

A magneto-resistance effect element according to the present invention comprises a lower conductive layer, a first magnetic layer provided on the lower electrically conductive, and a second magnetic layer provided on the first magnetic layer and magnetically coupled to the first magnetic layer. The magneto-resistance effect element also comprises a free layer provided on the second magnetic layer, magnetically coupled to the second magnetic layer, and having an orientation of magnetization varied by a magnetic field applied thereto. The magneto-resistance effect element further comprises a first non-magnetic layer provided on the free layer, a fixed layer provided on the first non-magnetic layer and having a pinned orientation of magnetization, and a vertical bias layer for applying a magnetic field to the first magnetic layer. The magneto-resistance effect element is adapted such that a sense

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

current for detecting a change in electrical resistance of the first non-magnetic layer flows substantially in perpendicular relation to the first non-magnetic layer.

Please replace the paragraph beginning at page 16, line 3, with the following rewritten paragraph:

Still furthermore, it is preferable that at least part of the first magnetic layer is in direct contact with the vertical bias layer. Alternatively, a first underlying layer for the magnetic layer may be provided below the first magnetic layer such that the underlying layer for the magnetic layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer such that the vertical bias layer protective layer is brought into contact with the magnetic layer or the underlying layer for the magnetic layer. Likewise, it is preferable that at least part of the second magnetic layer is in direct contact with the vertical bias layer. Alternatively, an upper layer may be provided on the second magnetic layer such that the upper layer is brought into contact with the vertical bias layer. The vertical bias layer protective layer may be provided below the vertical bias layer such that the vertical bias layer protective layer is brought into contact with the magnetic layer or the upper layer.

Please replace the paragraph beginning at page 17, line 14, with the following rewritten paragraph:

Still furthermore, it is preferable that at least part of the first magnetic layer is in direct contact with the vertical bias layer. Alternatively, an underlying layer for the magnetic layer may be provided below the first magnetic layer such that the underlying layer for the magnetic layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

such that the vertical bias layer protective layer is brought into contact with the magnetic layer or the underlying layer for the magnetic layer. Similarly, it is desirable that at least part of the second magnetic layer is in direct contact with the vertical bias layer. Alternatively, an upper layer may be provided on the second magnetic layer such that the upper layer is brought into contact with the vertical bias layer. An underlying layer for the vertical bias layer may be provided below the vertical bias layer such that the underlying layer for the vertical bias layer is brought into contact with the magnetic layer or the upper layer.

Please replace the paragraph beginning at page 18, line 3, with the following rewritten paragraph:

A magneto-resistance effect element according to the present invention comprises a lower conductive layer, a vertical bias layer provided on the lower conductive layer, a first magnetic layer provided on the vertical bias layer, and a second magnetic layer provided on the first magnetic layer and magnetically coupled to the first magnetic layer. The magneto-resistance effect element also comprises a free layer provided on the second magnetic layer, magnetically coupled to the second magnetic layer, and having an orientation of magnetization varied by a magnetic field applied thereto. The magneto-resistance effect element further comprises a first non-magnetic layer provided on the free layer, and a fixed layer provided on the first non-magnetic layer and having a pinned orientation of magnetization. The magneto-resistance effect element is adapted such that a sense current for detecting a change in electrical resistance of the first non-magnetic layer flows substantially in perpendicular relation to the first non-magnetic layer.

Please replace the paragraph beginning at page 19, line 16, with the following rewritten paragraph:

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Still furthermore, it is preferable that at least part of the first magnetic layer is in direct contact with the vertical bias layer. Alternatively, an underlying layer for magnetic layer may be provided below the first magnetic layer such that the underlying layer for the magnetic layer is brought into contact with the vertical bias layer. A vertical bias layer protective layer may be provided on the vertical bias layer such that the vertical bias layer protective layer is brought into contact with the magnetic layer or the underlying layer for the magnetic layer. Similarly, it is desirable that at least part of the second magnetic layer is in direct contact with the vertical bias layer. Alternatively, an upper layer may be provided on the second magnetic layer such that the upper layer is brought into contact with the vertical bias layer. An underlying layer for the vertical bias layer may be provided below the vertical bias layer such that the underlying layer for the vertical bias layer is brought into contact with the magnetic layer or the upper layer.

Please replace the paragraph beginning at page 27, line 1, with the following rewritten paragraph:

Then, as shown in Fig. 6, on the recessed portion 1a of the lower conductive layer 1, ~~deposited are~~ are deposited an underlying layer for vertical bias layer 2a and a vertical bias layer 2b so as to be partially buried in the recessed portion of the lower conductive layer 1, and thereafter the photoresist 20 is removed.

Please replace the paragraph beginning at page 27, line 6, with the following rewritten paragraph:

Then, as shown in Fig. 7, on the lower conductive layer 1 and the vertical bias layer 2b, formed and stacked in the following order are an underlying layer 3a for the

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

free layer ~~3a~~, a the free layer 3b, a non-magnetic layer 4, a fixed layer 5, a fixing layer 6b, and an upper layer 7.

Please replace the paragraph beginning at page 27, line 21, with the following rewritten paragraph:

Then, as shown in Fig. 9, the photoresist 21 is removed. Then, a magneto-resistance effect element 31a is formed which is made up of the lower conductive layer 1, the underlying layer 2a for the vertical bias layer ~~2a~~, the vertical bias layer 2b, the underlying layer 3a for the free layer ~~3a~~, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer.

Please replace the paragraph beginning at page 28, line 7, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head 61a according to this embodiment is described. As shown in Fig. 10, provided are the lower shield layer 16 and the lower conductive layer 1. The lower conductive layer 1 has the recessed portion 1a, and the recessed portion 1a is provided with the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b. The underlying layer 3a for the free layer ~~3a~~ and the free layer 3b are provided in the portion of the lower conductive layer 1, where ~~provided is~~ there is provided neither the underlying layer 2a for the vertical bias layer ~~2a~~ nor the vertical bias layer 2b, and also on the vertical bias layer 2b. On top of the free layer 3b, formed in the following order are the non-magnetic layer 4 patterned so as not to be disposed immediately above the vertical bias layer 2b, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Please replace the paragraph beginning at page 28, line 28, with the following rewritten paragraph:

In the aforementioned structure, the lower conductive layer 1 and the upper conductive layer 15 act as the upper and lower electrodes for conducting a sense current in the direction perpendicular to stacked layer planes. Here, the stacked layer planes are formed of the underlying layer 3a for the free layer-3a disposed between the lower conductive layer 1 and the upper conductive layer 15, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7. Materials forming the lower conductive layer 1 and the upper conductive layer 15 include a single material of one type, a mixture of materials of two or more types, a compound of materials of two or more types, or a multi-layered film formed of materials of two or more types, which are selected from the group consisting of Au, Ag, Cu, Mo, W, Y, Ti, Zr, Hf, V, Nb, Pt, and Ta. In particular, Au, Ag, Cu, Pt, and Ta are more favorable. In addition, materials forming the substrate include an altic, SiC, and alumina.

Please replace the paragraph beginning at page 29, line 17, with the following rewritten paragraph:

In addition, the vertical bias layer 2b is to apply a vertical bias magnetic field to the free layer 3b, while the underlying layer 2a for the vertical bias layer-2a is to improve the film quality such as the crystallization property of the vertical bias layer 2b and the magnetic properties of the vertical bias layer 2b. Materials forming the underlying layer 2a for the vertical bias layer-2a include a single material of one type, a mixture of materials of two or more types, or a multi-layered film formed of materials of two or more types, which are selected from the group consisting of Ta, Hf, Zr, W, Cr, Ti, Mo, Pt, Ni, Ir, Cu, Ag, Co, Zn, Ru, Rh, Re, Au, Os, Pd, Nb, V, Fe,

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

FeCo, FeCoNi, and NiFe. In particular, Cr, Fe, and CoFe are more favorable. On the other hand, materials forming the vertical bias layer 2b include a single material of one type, a mixture of materials of two or more types, or a multi-layered film formed of materials of two or more types, which are selected from the group consisting of CoCrPt, CoCr, CoPt, CoCrTa, FeMn, NiMn, Ni oxide, NiCo oxide, Fe oxide, NiFe oxide, IrMn, PtMn, PtPdMn, ReMn, Co ferrite, and Ba ferrite. In particular, CoCrPt, CoCrTa, CoPt, NiMn, and IrMn are more favorable.

Please replace the paragraph beginning at page 30, line 9, with the following rewritten paragraph:

When an external magnetic field is applied to a magnetic sensor including the magneto-resistance effect head 61a, the free layer 3b acting as a magnetic layer changes the orientation of magnetization in accordance with the direction and the magnitude of the magnetic field. An external magnetic field is applied to the free layer 3b via the vertical bias layer 2b. In addition, the underlying layer 3a for the free layer 3a is to improve the film quality such as the crystallization property of the free layer 3b and the magnetic properties of the free layer 3b. Materials forming the underlying layer 3a for the free layer 3a include a single material of one type, a mixture of materials of two or more types, a compound of materials of two or more types, or a multi-layered film formed of materials of two or more types, which are selected from the group consisting of Ta, Hf, Zr, W, Cr, Ti, Mo, Pt, Ni, Ir, Cu, Ag, Co, Zn, Ru, Rh, Re, Au, Os, Pd, Nb, and V. In particular, Ta, Zr, and Hf are more favorable. Materials forming the free layer 3b include alloys and amorphous magnetic materials such as NiFe, CoFe, NiFeCo, FeCo, CoFeB, CoZrMo, CoZrNb, CoZr, CoZrTa, CoHf, CoTa, CoTaHf, CoNbHf, CoZrNb, CoHfPd, CoTaZrNb, and CoZrMoNi. As an additive element, one or more types of elements selected from the group consisting of Ta, Hf, Zr, W, Cr, Ti, Mo, Pt, Ni, Ir, Cu, Ag, Co, Zn, Ru, Rh, Re,

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Au, Os, Pd, Nb, and V can also be employed. More favorable are NiFe, a two-layer film of NiFe/CoFe, a two-layer film of NiFe/NiFeCo, and a two-layer film of NiFe/Co.

Please replace the paragraph beginning at page 31, line 6, with the following rewritten paragraph:

The fixing layer 6b is to pin the orientation of magnetization of the fixed layer 5, while the underlying layer 6a for the fixing layer ~~6a~~ is to improve the film quality such as the crystallization property of the fixing layer 6b and the magnetic properties of the fixing layer 6b. On the other hand, the fixed layer 5 has an orientation of magnetization that is pinned by the fixing layer 6b.

Please replace the paragraph beginning at page 31, line 13, with the following rewritten paragraph:

Materials forming the underlying layer 6a for the fixing layer ~~6a~~ include includes a single material of one type, a mixture of materials of two or more types, a compound of materials of two or more types, or a multi-layered film formed of materials of two or more types, which are selected from the group consisting of Ta, Hf, Zr, W, Cr, Ti, Mo, Pt, Ni, Ir, Cu, Ag, Co, Zn, Ru, Rh, Re, Au, Os, Pd, Nb, and V. In particular, Ta, Zr, and Hf are more favorable. On the other hand, as a material for the fixing layer 6b, it is possible to employ FeMn, NiMn, IrMn, RhMn, PtPdMn, ReMn, PtMn, PtCrMn, CrMn, CrAl, TbCo, CoCr, CoCrPt, CoCrTa, PtCo and the like. In particular, a favorable material is PtMn or PtMn to which doped is at least one type of element selected from the group consisting of Ti, V, Cr, Co, Cu, Zn, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Hf, Ta, W, Re, Os, Ir, Pt, Au, Si, and Al.

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Please replace the paragraph beginning at page 34, line 20, with the following rewritten paragraph:

Furthermore, part of the direction of thickness of the patterned underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b is buried in the recessed portion 1a of the lower conductive layer 1. This provides a gradual slope to the end portion of the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b, thereby allowing the vertical bias layer 2b to apply a vertical bias magnetic field to the free layer 3b more effectively.

Please replace the paragraph beginning at page 35, line 19, with the following rewritten paragraph:

In addition, the underlying layer 2a for the vertical bias layer ~~2a~~, the underlying layer 3a for the free layer ~~3a~~, and the upper layer 7 may be omitted, and a protective layer for protecting the vertical bias layer may be provided on top of the vertical bias layer 2b.

Please replace the paragraph beginning at page 36, line 21, with the following rewritten paragraph:

Then, as shown in Fig. 15, the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b are deposited on top of the lower conductive layer 1 after the photoresist 20 has been removed.

Please replace the paragraph beginning at page 36, line 25, with the following rewritten paragraph:

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Then, as shown in Fig. 16, the photoresist 21 is formed to cover the region having the recessed portion 1a arranged immediately below the vertical bias layer 2b and provide an opening portion 21a for the region having no recessed portion 1a arranged immediately below the vertical bias layer 2b. Subsequently, with the photoresist 21 being employed as a mask, the underlying layer 2a for the vertical bias layer-2a and the vertical bias layer 2b are etched and thereby patterned by dry etching or like means.

Please replace the paragraph beginning at page 37, line 6, with the following rewritten paragraph:

Then, as shown in Fig. 17, on top of the lower conductive layer 1 and vertical bias layer 2b, formed and layered in the following order are the underlying layer 3a for the free layer-3a, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

Please replace the paragraph beginning at page 37, line 11, with the following rewritten paragraph:

Then, as shown in Fig. 18, a photoresist 22 is provided to cover the region having no vertical bias layer 2b arranged immediately below the upper layer 7. With the photoresist 22 being employed as a mask, the underlying layer 3a for the free layer 3a, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7 are patterned by dry etching or like means.

Please replace the paragraph beginning at page 38, line 8, with the following rewritten paragraph:

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Now, the structure of the magneto-resistance effect head 62a according to this embodiment is described below. As shown in Fig. 21, the magneto-resistance effect head 62a according to this embodiment has a different shape of the underlying layer 3a for the free layer ~~3a~~ and the free layer 3b in comparison with the magneto-resistance effect head 61a according to the first embodiment shown in Fig. 10. In this embodiment, the end portion of the underlying layer 3a for the free layer ~~3a~~ and the free layer 3b is flush and in contact with that of the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b. In the magneto-resistance effect head 62a according to this embodiment, the structure and operation thereof is the same as those of the magneto-resistance effect head 61a according to the aforementioned first embodiment except for the shape of the underlying layer for free layer 3a and the free layer 3b.

Please replace the paragraph beginning at page 39, line 19, with the following rewritten paragraph:

Then, as shown in Fig. 24, with the photoresist 20 being employed as a mask, the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b are deposited so as to partially fill in the recessed portion 1a of the lower conductive layer 1, and then the photoresist 20 is removed.

Please replace the paragraph beginning at page 39, line 24, with the following rewritten paragraph:

Then, as shown in Fig. 25, on top of the lower conductive layer 1 and the vertical bias layer 2b, formed and layered in the following order are the underlying layer 3a for the free layer ~~3a~~, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Please replace the paragraph beginning at page 40, line 10, with the following rewritten paragraph:

Then, as shown in Fig. 27, the photoresist 21 is removed to form the photoresist 22, patterned to cover a region broader than that covered by the photoresist 21, at a position on the upper layer 7 and the insulation layer 11 where the photoresist 21 has once been formed. With the photoresist 22 being employed as a mask, the underlying layer 3a for the free layer ~~3a~~, the free layer 3b, and the insulation layer 11 are etched by dry etching or like means and thereby patterned. Subsequently, this etched region is buried in the insulation layer 11b to thereby form a magneto-resistance effect element 32b.

Please replace the paragraph beginning at page 41, line 13, with the following rewritten paragraph:

Then, as shown in Fig. 29, on top of the lower conductive layer 1 and the vertical bias layer 2b, the following layers are formed and layered. That is, an underlying layer 8a for the magnetic layer ~~8a~~, a magnetic layer 8b, a second non-magnetic layer 9, the free layer 3b, the first non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7 are formed and layered in that order.

Please replace the paragraph beginning at page 42, line 13, with the following rewritten paragraph:

As shown in Fig. 31, the lower shield layer 16 and the lower conductive layer 1 are provided on the substrate (not shown), the lower conductive layer 1 has the recessed portion 1a, and the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b are provided on the recessed portion 1a. On top of the portion

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

having no underlying layer for vertical bias layer 2a and no vertical bias layer 2b on the lower conductive layer 1 and on top of the vertical bias layer 2b, provided are the underlying layer 8a for the magnetic layer ~~8a~~ and the magnetic layer 8b. On top of the magnetic layer 8b, layered in the following order are the second non-magnetic layer 9 that is not patterned immediately above the vertical bias layer 2b, the free layer 3b, the first non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

Please replace the paragraph beginning at page 43, line 7, with the following rewritten paragraph:

In the aforementioned structure, the magnetic layer 8b is to transmit a vertical bias magnetic field applied by the vertical bias layer 2b to the free layer 3b by means of magnetic coupling such as ferromagnetic coupling, antiferromagnetic coupling, or magneto-static coupling. In addition, the second non-magnetic layer 9 allows the component material and the film thickness thereof to control the magnetic coupling between the magnetic layer 8b and the free layer 3b. The underlying layer 8a for the magnetic layer ~~8a~~ is to improve film quality such as the crystallization properties of the magnetic layer 8b and provide good magnetic properties for the magnetic layer 8b. Incidentally, the non-magnetic layer 4 is an insulation layer for conducting a tunneling current therethrough, whereas the second non-magnetic layer 9 is an electrically conductive layer for controlling the magnetic coupling between the magnetic layer 8b and the free layer 3b.

Please replace the paragraph beginning at page 44, line 5, with the following rewritten paragraph:

Materials forming the second non-magnetic layer 9 include a single material of one type, a mixture of materials of two or more types, a compound of two or more

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

types, or a multi-layered film formed of materials of two or more types, which are selected from the group consisting of Ti, V, Cr, Co, Cu, Zn, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Hf, Ta, W, Re, Os, Ir, Pt, Au, Si, Al, Ti, Ta, Pt, Ni, Co, Re, and V. In particular, Ru and Cr are favorable. Materials forming the underlying layer 8a for the magnetic layer ~~8a~~ include a single material of one type, a mixture of materials of two or more types, a compound of two or more types, or a multi-layered film formed of materials of two or more types, which are selected from the group consisting of Ta, Hf, Zr, W, Cr, Ti, Mo, Pt, Ni, Ir, Cu, Ag, Co, Zn, Ru, Rh, Re, Au, Os, Pd, Nb, and V. In particular, Ta and Zr are more favorable.

Please replace the paragraph beginning at page 46, line 26, with the following rewritten paragraph:

In addition, the underlying layer 2a for the vertical bias layer ~~2a~~, the underlying layer 8a for magnetic layer ~~8a~~, the second non-magnetic layer 9, and the upper layer 7 may be omitted, and a protective layer for protecting the vertical bias layer may be provided on top of the vertical bias layer 2b.

Please replace the paragraph beginning at page 47, line 24, with the following rewritten paragraph:

Then, as shown in Fig. 34, the photoresist 21 is removed. Then, on top of the exposed portion of the lower conductive layer 1 and the vertical bias layer 2b, formed and layered are the following layers. That is, the underlying layer 8a for the magnetic layer ~~8a~~, the magnetic layer 8b, the second non-magnetic layer 9, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7 are formed and layered in that order.

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Please replace the paragraph beginning at page 48, line 4, with the following rewritten paragraph:

Then, as shown in Fig. 35, the photoresist 22 is provided to cover the region having no vertical bias layer 2b arranged immediately below the upper surface of the upper layer 7. With the photoresist 22 being employed as a mask, patterned by dry etching or like means are the underlying layer 8b for the magnetic layer-~~8a~~, the magnetic layer 8b, the second non-magnetic layer 9, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

Please replace the paragraph beginning at page 49, line 2, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head 64a according to this embodiment is described below. As shown in Fig. 37, the magneto-resistance effect head 64a according to this embodiment has a different shape of the underlying layer 8a for the magnetic layer-~~8a~~ and the magnetic layer 8b in comparison with the magneto-resistance effect head 63a according to the fourth embodiment shown in Fig. 31. In this embodiment, the underlying layer 8a for the magnetic layer-~~8a~~ and the magnetic layer 8b are patterned to allow their end portion to be flush with the end portion of the underlying layer for vertical bias layer 2a and the vertical bias layer 2b and in contact with each other. In the magneto-resistance effect head 64a according to this embodiment, the structural operation and effect thereof are the same as those of the magneto-resistance effect head 63a according to the aforementioned fourth embodiment except the shape of the underlying layer 8a for the magnetic layer-~~8a~~ and the magnetic layer 8b.

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Please replace the paragraph beginning at page 50, line 13, with the following rewritten paragraph:

Then, as shown in Fig. 38, the photoresist 20 is removed. Then, on the lower conductive layer 1, formed and layered in the following order are the underlying layer 8a for the magnetic layer 8a, the magnetic layer 8b, the second non-magnetic layer 9, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

Please replace the paragraph beginning at page 51, line 7, with the following rewritten paragraph:

Then, as shown in Fig. 41, with the photoresist 22 being employed as a mask, the insulation layer 11, the underlying layer 8a for the magnetic layer ~~8a~~, and the magnetic layer 8b are patterned by etching. Subsequently, the ~~Underlying layer~~ vertical bias underlying layer 2a and the vertical bias layer 2b are formed successively, a second insulation layer 11b is formed on the vertical bias layer 2b, and a magneto-resistance effect element 34b is formed on the lower conductive layer 16.

Please replace the paragraph beginning at page 52, line 8, with the following rewritten paragraph:

Then, as shown in Fig. 44, formed and layered in the following order are the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9.

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Please replace the paragraph beginning at page 52, line 12, with the following rewritten paragraph:

Then, as shown in Fig. 45, the photoresist 20 is patterned on the second non-magnetic layer 9. Then, the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are patterned by dry etching or like means. A pattern 29a is thereby formed which comprises the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9, which have been patterned.

Please replace the paragraph beginning at page 52, line 26, with the following rewritten paragraph:

Then, as shown in Fig. 47, on the insulation layer 11, formed are the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b. And, the vertical bias layer 2b is varied in thickness along the slope of the insulation layer 11, allowing the vertical bias layer 2b to be thick in thickness at a given distance from the pattern 29a and reduced in thickness with increasing proximity to the pattern 29a.

Please replace the paragraph beginning at page 53, line 15, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head 65a according to this embodiment is described below. As shown in Fig. 49, the lower shield layer 16 is provided and the lower conductive layer 1 is provided on the lower shield layer 16. On top of the lower conductive layer 1, formed is the pattern 29a made up of the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9, which have been patterned. The insulation layer 11 is arranged on the periphery of the pattern 29a, and the pattern 29a is buried in the insulation layer 11.

Please replace the paragraph beginning at page 55, line 12, with the following rewritten paragraph:

Incidentally, in this embodiment, ~~it has been explained in which the~~ underlying layer 6a for ~~the~~ fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are patterned in the same way. However, it is necessary to pattern at least the free layer 3b but not necessary to pattern the underlying layer 6a for ~~the~~ fixing layer 6a, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer 4. In addition, the pattern of the underlying layer 6a for ~~the~~ fixing layer ~~6a~~ may be extended further than that of the fixing layer 6b. The pattern of the fixing layer 6b may be extended further than that of the fixed layer 5. The pattern of the fixed layer 5 may be extended further than that of the non-magnetic layer 4. The pattern of the non-magnetic layer 4 may be extended further than that of the free layer 3b. Furthermore, this embodiment has shown that the upper surface of the insulation layer 11 is lower than that of the pattern of the free layer 3b. However, the upper surface of the insulation layer 11 may be equal in height to the upper surface of the pattern of the free layer 3b and higher than the upper surface of the pattern of the free layer 3b.

Please replace the paragraph beginning at page 56, line 4, with the following rewritten paragraph:

Figs. 50 - 54 are fragmentary sectional views illustrating the structure of a magneto-resistance effect element according to a variation of this embodiment. A

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

magneto-resistance effect element 35b shown in Fig. 50 is different from the magneto-resistance effect element 35a shown in Fig. 49 in that the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer 4 are not patterned. On the first non-magnetic layer 4, provided are the free layer 3b and the second non-magnetic layer 9, and these patterns are buried in the insulation layer 11. The magneto-resistance effect element 35b has the same structure as that of the magneto-resistance effect element 35a except the topography of the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer 4. The operation of the magneto-resistance effect element 35b is also the same as that of the magneto-resistance effect element 35a.

Please replace the paragraph beginning at page 56, line 20, with the following rewritten paragraph:

In comparison with the magneto-resistance effect element 35a, the magneto-resistance effect element 35b is advantageous in that the etching process for the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer 4 can be omitted upon fabrication.

Please replace the paragraph beginning at page 56, line 25, with the following rewritten paragraph:

This variation has shown that the free layer 3b and the second non-magnetic layer 9 are patterned by etching of the first non-magnetic layer 4 using the photoresist as a mask. However, it is necessary to pattern at least the free layer 3b, and it can be selected as appropriate which layers to pattern in the layered body made up of the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer.

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Please replace the paragraph beginning at page 57, line 21, with the following rewritten paragraph:

This variation has shown that the free layer 3b and the second non-magnetic layer 9 are patterned. However, it is necessary to pattern at least the free layer 3b, but it can be selected as appropriate which layers to pattern in the layered body made up of the underlying layer 6a for the fixing layer-6a, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer.

Please replace the paragraph beginning at page 59, line 8, with the following rewritten paragraph:

In addition, the underlying layer 2a for the vertical bias layer-2a, the underlying layer 6a for the fixing layer 6a, the second non-magnetic layer 9, and the upper layer 7 may be omitted, and a protective layer for protecting the vertical bias layers may be provided on the vertical bias layer 2b.

Please replace the paragraph beginning at page 59, line 21, with the following rewritten paragraph:

Then, as shown in Fig. 59, formed and layered in the following order are the underlying layer 6a for the fixing layer-6a, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer.

Please replace the paragraph beginning at page 59, line 25, with the following rewritten paragraph:

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Then, as shown in Fig. 60, the photoresist 20 having the opening portion 20a is formed on top of the second non-magnetic layer 9. Then, patterned are the underlying layer 6a for the fixing layer 6a, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 by dry etching or like means. Thus, a pattern 29c is formed which is made up of the patterned the underlying layer 6a for the fixing layer 6a, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9, which have been patterned.

Please replace the paragraph beginning at page 60, line 26, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head 66a according to this embodiment is described below. As shown in Fig. 64, the magneto-resistance effect head 66a is provided with the lower shield layer 16, and the lower conductive layer 1 is provided on top of the lower shield layer 16. Thus, on top of the lower conductive layer 1, formed is the pattern 29c made up of the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9, which have been patterned. The insulation layer 11 is arranged around the pattern 29c, and the pattern 29c is buried in the insulation layer 11.

Please replace the paragraph beginning at page 64, line 9, with the following rewritten paragraph:

Incidentally, in this embodiment, the underlying layer 6a for the fixing layer 6a, the second non-magnetic layer 9, the third non-magnetic layer 13, and the upper layer 7 may be omitted. In addition, an underlying layer 2a for the vertical bias layer

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

may be provided on the lower portion of the vertical bias layer 2b. In some cases, a protective layer for protecting a vertical bias layer is provided on the vertical bias layer 2b, and an upper layer is provided on the second magnetic layer 12.

Please replace the paragraph beginning at page 64, line 17, with the following rewritten paragraph:

Furthermore, in this embodiment, ~~it has been explained in which the~~ underlying layer 6a for ~~the~~ fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are patterned in the same way. However, it is necessary to pattern at least the free layer 3b but not necessary to pattern the layered film made up of the underlying layer 6a for ~~the~~ fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer 4. In addition, the pattern of the underlying layer 6a for ~~the~~ fixing layer ~~6a~~ may be extended further than that of the fixing layer 6b. The pattern of the fixing layer 6b may be extended further than that of the fixed layer 5. The pattern of the fixed layer 5 may be extended further than that of the non-magnetic layer 4. The pattern of the non-magnetic layer 4 may be extended further than that of the free layer 3b. In addition, this embodiment has shown ~~such~~ that the upper surface of the insulation layer 11 is equal in height to that of the pattern of the free layer 3b. However, the upper surface of the insulation layer 11 may be lower than that of the pattern of the free layer 3b or higher than the upper surface of the pattern of the free layer 3b. Furthermore, Fig. 64 has shown that the second non-magnetic layer 9 and the free layer 3b are patterned in the same way. However, the pattern of the second non-magnetic layer 9 may be extended further than that of the free layer 3b.

Please replace the paragraph beginning at page 65, line 13, with the following rewritten paragraph:

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

Figs. 65 - 66 are fragmentary sectional views illustrating the structure of a magneto-resistance effect element according to a variation of this embodiment. With reference to Fig. 64, it has been shown ~~in which~~ that the first magnetic layer 8, the third non-magnetic layer 13, and the second magnetic layer 12 are not patterned. However, in a magneto-resistance effect element 36b shown in Fig. 65, the end portion of patterns of the magnetic layer 8, the third non-magnetic layer 13, and the second magnetic layer 12 is arranged under the pattern of the vertical bias layer 2b.

Please replace the paragraph beginning at page 66, line 15, with the following rewritten paragraph:

Then, as shown in Fig. 68, with the photoresist 21 being employed as a mask, a recessed portion 11a is formed in the insulation layer 11, and the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b are formed so as to be buried in the recessed portion 11a.

Please replace the paragraph beginning at page 67, line 3, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head 67a according to this embodiment is described below. The magneto-resistance effect head 67a is provided with the lower shield layer 16, and the lower conductive layer 1 is provided on the lower shield layer 16. Then, formed on top of the lower conductive layer 1 is the pattern in which the underlying layer 6a for the fixing layer ~~6a~~ patterned on the fixing layer 6b, the fixed layer 5, non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are layered in that order, and this pattern is buried in the insulation layer 11. As shown in Fig. 70, the insulation layer 11 has the recessed portion 11a on the upper surface thereof, and the underlying layer 2a for the vertical

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

bias layer ~~2a~~ and the vertical bias layer 2b are formed so as to be buried in the recessed portion 11a. Then, on the second non-magnetic layer 9, the insulation layer 11, and the vertical bias layer 2b, formed are the magnetic layer 8, the third non-magnetic layer 13, and the second magnetic layer 12. Furthermore, the patterned upper conductive layer 15 is provided on the second magnetic layer 12, and the upper shield layer 17 is provided on the pattern of the second magnetic layer 12 and the upper conductive layer 15.

Please replace the paragraph beginning at page 68, line 4, with the following rewritten paragraph:

Then, as shown in Fig. 72, the following layers are formed and layered on the lower conductive layer 1. That is, the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, the second non-magnetic layer 9, the first magnetic layer 8, the third non-magnetic layer 13, the second magnetic layer 12, the underlying layer 2a for the vertical bias layer ~~2a~~, and the vertical bias layer 2b are formed and layered in that order.

Please replace the paragraph beginning at page 68, line 14, with the following rewritten paragraph:

Then, as shown in Fig. 74, with the photoresist 20 being employed as a mask, etched by dry etching or like means and thereby patterned are the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the non-magnetic layer 4, the free layer 3b, the second non-magnetic layer 9, the magnetic layer 8, the third non-magnetic layer 13, the second magnetic layer 12, the underlying layer 2a for the vertical bias layer ~~2a~~, and the vertical bias layer 2b. Thus, a pattern 29d is formed which is made up of the underlying layer for fixing layer 6a, the fixing layer 6b, the

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

fixed layer 5, the non-magnetic layer 4, the free layer 3b, the second non-magnetic layer 9, the magnetic layer 8, the third non-magnetic layer 13, the second magnetic layer 12, the underlying layer 2a for the vertical bias layer-2a, and the vertical bias layer 2b.

Please replace the paragraph beginning at page 69, line 10, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head according to this embodiment is described below. As shown in Fig. 76, the magneto-resistance effect head is provided with a lower shield layer (not shown), and the lower conductive layer 1 is provided on a lower shield layer. On top of the lower conductive layer 1, provided is the pattern 29d made up of the underlying layer 6a for the fixing layer-6a, the fixing layer 6b, the fixed layer 5, non-magnetic layer 4, the free layer 3b, the second non-magnetic layer 9, the first magnetic layer 8, the third non-magnetic layer 13, the second magnetic layer 12, the underlying layer 2a for the vertical bias layer-2a, and the vertical bias layer 2b, which have been patterned. The pattern 29d is buried in the insulation layer 11, and the vertical bias layer 2b of the pattern 29d is exposed on the upper surface of the insulation layer 11. In addition, the upper conductive layer 15, which has been patterned, is provided on top of the pattern 29d and the insulation layer 11, and the upper shield layer 17 is provided on the upper conductive layer 15 and the insulation layer 11.

Please replace the paragraph beginning at page 70, line 24, with the following rewritten paragraph:

Incidentally, the underlying layer 6a for the fixing layer 6a, the second non-magnetic layer 9, the third non-magnetic layer 13, and the underlying layer 2a for the

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

vertical bias layer ~~2a~~ can be omitted. Incidentally, a protective layer for protecting the vertical bias layer 2b may be provided on the vertical bias layer 2b, while an upper layer may be provided on the second magnetic layer 12.

Please replace the paragraph beginning at page 71, line 3, with the following rewritten paragraph:

Fig. 77 is a fragmentary sectional view illustrating the structure of a magneto-resistance effect element 38b according to a variation of this embodiment. The magneto-resistance effect element 38b is provided with the lower conductive layer 1 on a substrate (not shown). On top of the lower conductive layer 1, provided are the underlying layer 6a for ~~the~~ fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, non-magnetic layer 4, the free layer 3b, the second non-magnetic layer 9, the first magnetic layer 8, the underlying layer 2a for ~~the~~ vertical bias layer ~~2a~~, and the vertical bias layer 2b. And, these layers have been patterned and buried in the insulation layer 11. The vertical bias layer 2b is exposed on the upper surface of the insulation layer 11.

Please replace the paragraph beginning at page 72, line 2, with the following rewritten paragraph:

Incidentally, in this embodiment, it has been explained in which the underlying layer 6a for ~~the~~ fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are patterned in the same way. However, it is necessary to pattern at least the free layer 3b but not necessary to pattern the layered film made up of the underlying layer 6a for ~~the~~ fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, and the non-magnetic layer 4. In addition, the pattern of the underlying layer 6a for ~~the~~ fixing layer ~~6a~~ may be extended further than that of the fixing layer 6b. The pattern of the fixing layer 6b

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

may be extended further than that of the fixed layer 5. The pattern of the fixed layer 5 may be extended further than that of the non-magnetic layer 4. The pattern of the first non-magnetic layer 4 may be extended further than that of the free layer 3b.

Please replace the paragraph beginning at page 72, line 25, with the following rewritten paragraph:

Then, as shown in Fig. 79, the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are formed and layered in that order on the lower conductive layer 1.

Please replace the paragraph beginning at page 73, line 2, with the following rewritten paragraph:

Then, as shown in Fig. 80, the photoresist 20 is patterned on the second non-magnetic layer 9. Then, the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are patterned by dry etching or like means, thereby forming a pattern 29e made up of these layers.

Please replace the paragraph beginning at page 73, line 14, with the following rewritten paragraph:

Then, as shown in Fig. 82, on the insulation layer 11, formed are the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b. The vertical bias layer 2b is varied in thickness along the slope of the insulation layer 11,

01FN046US
Amendment dated 09/22/2003

09/916,529
Reply to office action mailed 06/23/2003

02230028aa

allowing the vertical bias layer 2b to be thick in thickness at a given distance from the pattern 29e and reduced in thickness with increasing proximity to the pattern 29e.

Please replace the paragraph beginning at page 74, line 20, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect element 39a according to this embodiment is described below. As shown in Fig. 87, the magneto-resistance effect element 39a is adapted that the non-magnetic layer, the free layer, the non-magnetic layer, the fixed layer, and the fixing layer are formed to be vertically symmetric with respect to the second non-magnetic layer 8b to which a vertical bias magnetic field is applied from the underlying layer 2a for the vertical bias layer 2a.

Please replace the paragraph beginning at page 74, line 28, with the following rewritten paragraph:

The magneto-resistance effect element 39a is provided with the lower shield layer 16, and the lower conductive layer 1 is provided on the lower shield layer 16. On top of the lower conductive layer 1, formed is the pattern 29e made up of the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9, which have been patterned. The pattern 29e is buried in the insulation layer 11.

Please replace the paragraph beginning at page 75, line 8, with the following rewritten paragraph:

The upper surface of the insulation layer 11 is generally flush with that of the pattern 29e near the pattern 29e but is slightly lower than the upper surface of the

01FN046US

09/916,529

02230028aa

Amendment dated 09/22/2003

Reply to office action mailed 06/23/2003

pattern 29e at a given distance from the pattern 29e. The pattern of the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b is provided to allow at least part thereof in the direction of film thickness to be buried in the insulation layer 11. The second non-magnetic layer 8 is provided on the pattern 29e and the vertical bias layer 2b.

Please replace the paragraph beginning at page 77, line 24, with the following rewritten paragraph:

Incidentally, in this embodiment, the underlying layer 2a for the vertical bias layer ~~2a~~, the underlying layer 6a for the fixing layer ~~6a~~, the second non-magnetic layer 9, the fourth magnetic layer 18, and the upper layer 7 can be omitted. Furthermore, in some cases, a protective layer for protecting the vertical bias layer 2b may be provided on the vertical bias layer ~~2b~~ itself.

Please replace the paragraph beginning at page 78, line 2, with the following rewritten paragraph:

In addition, in this embodiment, ~~it has been explained in which~~ the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, the first non-magnetic layer 4, the free layer 3b, and the second non-magnetic layer 9 are patterned in the same way. However, it is necessary to pattern at least the free layer 3b but not necessary to pattern the underlying layer 6a for the fixing layer ~~6a~~, the fixing layer 6b, the fixed layer 5, and the first non-magnetic layer 4. Furthermore, the pattern of the underlying layer 6a for the fixing layer ~~6a~~ may be extended further than that of the fixing layer 6b. The pattern of the fixing layer 6b may be extended further than that of the fixed layer 5. The pattern of the fixed layer 5 may be extended further than that

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

of the non-magnetic layer 4. The pattern of the first non-magnetic layer 4 may be extended further than that of the free layer 3b.

Please replace the paragraph beginning at page 79, line 21, with the following rewritten paragraph:

Then, as shown in Fig. 91, on the lower conductive layer 1 and the vertical bias layer 2b, layered in sequence are a second underlying layer 12a for a second magnetic layer ~~12a~~, ~~a~~the second magnetic layer 12b, the third non-magnetic layer 13, the ~~second~~first magnetic layer 8, the second non-magnetic layer 9, the free layer 3b, the first non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

Please replace the paragraph beginning at page 80, line 16, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head 69b according to this embodiment is described below. As shown in Fig. 94, the magneto-resistance effect head 69b is provided with the lower shield layer 16, while the lower conductive layer 1 is provided on the lower shield layer 16. The recessed portion 1a is provided on the upper surface of the lower conductive layer 1, and the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b are provided so as to be in the recessed portion 1a. On the lower conductive layer and the vertical bias layer 2b, provided are the second underlying layer 12a for the magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8. A pattern made up of the second non-magnetic layer 9, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7 is formed

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

immediately above the portion surrounded by the pattern of the two vertical bias layers on the magnetic layer 8.

Please replace the paragraph beginning at page 81, line 14, with the following rewritten paragraph:

In addition, the underlying layer 2a for the vertical bias layer ~~2a~~, the second ~~non-Underlying~~ underlying layer 12a for the second magnetic layer ~~12a~~, and the upper layer 7 can be omitted. A protective layer for protecting the vertical bias layer can be provided on the upper part of the vertical bias layer 2b. Furthermore, the second underlying layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8 do not always have to extend as shown in Fig. 94.

Please replace the paragraph beginning at page 81, line 22, with the following rewritten paragraph:

Figs. 95 and Fig. 96 are fragmentary sectional views illustrating the structure of a magneto-resistance effect element according to a variation of this embodiment. Fig. 95 shows that the end portion of the second underlying layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8 is in contact with that of the pattern of the vertical bias layer 2b.

Please replace the paragraph beginning at page 82, line 1, with the following rewritten paragraph:

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

In addition, Fig. 96 shows that the end portion of the second underlying layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8 sits on the pattern of the vertical bias layer 2b.

Please replace the paragraph beginning at page 82, line 17, with the following rewritten paragraph:

Then, as shown in Fig. 98, the underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b are deposited on the lower conductive layer 1.

Please replace the paragraph beginning at page 82, line 20, with the following rewritten paragraph:

Then, as shown in Fig. 99, layered sequentially are the second underlying layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, the magnetic layer 8, the second non-magnetic layer 9, the underlying layer 3a for the free layer ~~3a~~, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7.

Please replace the paragraph beginning at page 83, line 15, with the following rewritten paragraph:

Now, the structure of the magneto-resistance effect head 69c according to this embodiment is described below. As shown in Fig. 102, the magneto-resistance effect head 69c has the lower conductive layer 1 provided on the lower shield layer 16. The underlying layer 2a for the vertical bias layer ~~2a~~ and the vertical bias layer 2b are provided thereupon. Further formed thereupon are the second underlying layer 12a

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the magnetic layer 8. On the magnetic layer 8, ~~provided are~~ are provided the second non-magnetic layer 9, the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7, which have been patterned and buried in the insulation layer 11. In addition, the upper conductive layer 15 is provided on the upper layer 7 and the insulation layer 11, upon which ~~provided is~~ is provided the upper shield layer.

Please replace the paragraph beginning at page 84, line 2, with the following rewritten paragraph:

In this embodiment, ~~it has been shown in which~~ the second underlying layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8 are patterned. However, the second non-magnetic layer 9 may extend like the pattern of the first magnetic layer 8. Alternatively, the second non-magnetic layer 9 may be extended further than the pattern of the free layer 3b, the non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7 and may be smaller than the pattern of the magnetic layer 8.

Please replace the paragraph beginning at page 84, line 12, with the following rewritten paragraph:

In addition, the vertical bias film underlying layer 2a, the second ~~non-underlying~~ underlying layer for the second magnetic layer ~~12a~~, and the upper layer 7 can be omitted. Furthermore, a protective layer for protecting the vertical bias layer can be provided above the vertical bias layer 2b. Furthermore, the second underlying

01FN046US
Amendment dated 09/22/2003

09/916,529

02230028aa
Reply to office action mailed 06/23/2003

layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8 do not always have to extend.

Please replace the paragraph beginning at page 84, line 20, with the following rewritten paragraph:

Figs. 103 and 104 are fragmentary sectional views illustrating the structure of a magneto-resistance effect element according to a variation of this embodiment. Fig. 103 shows that the second underlying layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8 are patterned.

Please replace the paragraph beginning at page 84, line 26, with the following rewritten paragraph:

In addition, Fig. 104 shows that the second underlying layer 12a for the second magnetic layer ~~12a~~, the second magnetic layer 12b, the third non-magnetic layer 13, and the first magnetic layer 8 are patterned to be generally equal in size to the pattern of the second non-magnetic layer 9, the free layer 3b, the first ~~the~~ non-magnetic layer 4, the fixed layer 5, the fixing layer 6b, and the upper layer 7. The magneto-resistance effect element shown in Figs. 103 and 104 can also be employed for the magneto-resistance effect head.